9.0 EQUIVALENCY DETERMINATION TO RACT CTG

Total Building 110 pre-control VOC emissions would be reduced by 10.75 TPY from 29.34 TPY to 18.59 TPY through implementation of the proposed RACT standard. Implementation of the general RACT guidelines described in IAC 8-5-3 would reduce emissions by 17.23 TPY. Implementation of the RACT CTG would reduce Building 110 VOC emissions by 6.48 TPY more than the proposed RACT standard at an incremental capital investment of $1,815,462. Table 9.1 summarizes the RACT comparison information presented in Table 9.2.

Table 9.1 ***Summary Comparison of Proposed Versus CTG RACT***

Pre-Control VOC Emissions	Proposed Emissions After Proposed RACT	Emissions After CTG RACT	Difference	Incremental Capital Cost
29.34 TPY	18.59 TPY	12.11 TPY	6.48 TPY	$1,815,462

A detailed summary of the comparison of the proposed RACT standard to the general RACT standard is described in the following sections.

9.1 *REACTORS*

The proposed RACT for Building 110 reactors will reduce VOC emissions by 10.72 TPY. The general RACT CTG described in IAC 8-5-3(b)(1) would reduce VOC emissions from Building 110 reactors by 12.77 TPY.

9.2 *CENTRIFUGES*

One portable centrifuge will be installed in Building 110 and infrequently utilized for solids separations. This unit is fully enclosed; VOC containing fluids will not be exposed to the atmosphere. If the portable centrifuge was utilized for 100% of Building 110 solids separation operations, the general RACT CTG described in IAC 8-5-3(b)(1) could reduce VOC emissions by 2.47 TPY more than the RACT proposed for the Building 110 centrifuge. The proposed RACT is fully consistent with the general RACT guidelines for centrifuges described in 326 IAC 8-5-3(b)(4).

TABLE 9.2

COMPARISION OF PROPOSED VS CTG RACT

MODULE		EMISSIONS (TPY) Reactors	Filters/ Centrifuges	Vacuum Dryers	Storage Tanks	Equipment Leaks	Total	Incremental* Ract CTG Capital Cost	Incremental* Ract CTG Annual Cost	Cost per Ton Controlled ($)	Incremental* Cost per Ton Controlled ($)
A	Pre-control	2.26	0.40	0.36		1.02	4.04				
	Proposed RACT	0.93	0.40	0.36		1.02	2.71				
	CTG RACT	0.52	0.09	0.08		1.02	1.71	$283,936	$84,046	$36,123	
	* Incremental Reduction:	0.41	0.31	0.28		0.00	1.00				$84,331
B	Pre-control	1.16	0.40	0.25		1.02	2.83				
	Proposed RACT	0.40	0.40	0.25		1.02	2.07				
	CTG RACT	0.27	0.09	0.06		1.02	1.44	$283,936	$83,986	$80,230	
	* Incremental Reduction:	0.13	0.31	0.19		0.00	0.63				$134,021
C	Pre-control	1.71	0.40	0.30		1.02	3.43				
	Proposed RACT	0.59	0.40	0.30		1.02	2.31				
	CTG RACT	0.39	0.09	0.07		1.02	1.57	$283,936	$84,015	$45,251	
	* Incremental Reduction:	0.20	0.31	0.23		0.00	0.74				$113,825
D	Pre-control	3.73	0.40	0.50		1.02	5.65				
	Proposed RACT	1.28	0.40	0.50		1.02	3.20				
	CTG RACT	0.86	0.09	0.11		1.02	2.08	$283,936	$84,124	$23,584	
	* Incremental Reduction:	0.43	0.31	0.39		0.00	1.12				$74,892
E	Pre-control	3.36	0.40	0.46		1.02	5.24				
	Proposed RACT	1.16	0.40	0.46		1.02	3.04				
	CTG RACT	0.77	0.09	0.11		1.02	1.99	$127,942	$50,460	$15,518	
	* Incremental Reduction:	0.38	0.31	0.35		0.00	1.05				$48,042
F	Pre-control	3.36	0.40	0.46		1.02	5.24				
	Proposed RACT	1.16	0.40	0.46		1.02	3.04				
	CTG RACT	0.77	0.09	0.11		1.02	1.99	$127,942	$50,460	$15,518	
	* Incremental Reduction:	0.38	0.31	0.35		0.00	1.05				$48,042
30 Gal-A	Pre-control	0.11	0.20	0.04		0.14	0.49				
	Proposed RACT	0.04	0.20	0.04		0.14	0.42				
	CTG RACT	0.03	0.05	0.01		0.14	0.22	$127,942	$50,259	$186,393	
	* Incremental Reduction:	0.01	0.15	0.03		0.00	0.19				$280,301
30 Gal-B	Pre-control	0.10	0.20	0.04		0.11	0.45				
	Proposed RACT	0.03	0.20	0.04		0.11	0.38				
	CTG RACT	0.02	0.05	0.01		0.11	0.19	$127,942	$50,258	$191,871	
	* Incremental Reduction:	0.01	0.15	0.03		0.00	0.19				$284,605
C-Wing	Pre-control	0.79	0.40	0.18		0.57	1.94				
	Proposed RACT	0.27	0.40	0.18		0.57	1.42				
	CTG RACT	0.18	0.09	0.04		0.57	0.89	$127,942	$50,309	$47,966	
	* Incremental Reduction:	0.09	0.31	0.14		0.00	0.54				$93,789
Acetone Tank	Pre-control				0.03		0.03				
	Proposed RACT				0.00		0.00				
	CTG RACT				0.03		0.03				
	Incremental Reduction:				-0.03		-0.03				
TOTAL	Pre-control	18.58	3.20	2.59	0.03	6.94	29.34				
	Proposed RACT	5.86	3.20	2.59	0.00	6.94	18.59				
	CTG RACT	3.81	0.73	0.59	0.03	6.94	12.11	$1,815,462	$587,896	$34,113	
	* Incremental Reduction:	2.05	2.47	2.00	-0.03	0.00	6.48				$90,678

* Incremental emissions reduction and cost of CTG RACT compared to Proposed RACT

Proposed RACT for reactors is -10 Deg C or colder (fluid inlet temp.) primary condenser, which has 82.0% removal efficiency over 80% of emissions stream. The other 20% is from aqueous solutions and cannot be controlled by condensation at this temperature due to freezing problems. One 100 gallon reactor in Module A is not equipped with a primary condenser.

CTG RACT for reactors and dryers is -25 Deg C condenser, which has 86.3% removal efficiency over 80% of emissions stream. The other 20% is from aqueous solutions and cannot be controlled by condensation at this temperature due to freezing problems.

9.3 *FILTERS*

During the filtration process, solids containing fluid is pressured from a reactor vessel through a filter. The filtered fluid is sent to a receiving reactor vessel. VOC containing fluids are not exposed to the atmosphere during this process. VOC emissions resulting from vapor displaced from the receiving vessel are controlled by that vessel's primary condenser.

After the filtration process, the filter must be opened to allow transfer of solids from the filter to drying equipment. The filters are opened under a walk-in hood; resulting VOC emissions are removed from the work area by a production exhaust system. The minimum flow rate through a production exhaust system is approximately 3,600 acfm. Available data (see Appendix A) indicate that less than 5 lb VOC per filtration is emitted to a Building 110 filter production exhaust system. 326 IAC 8-5-3(b)(2)(B) requires that emissions from production exhaust systems be limited to 33 lb/day.

Though unlikely, VOC emissions from a Building 110 production exhaust system could exceed 33 lb/day. 326 IAC 8-5-3(b)(2)(B) allows the commissioner to waive the 33 lb/day limitation if the owner can show that controls are not practical at a reasonable cost because of dilution of the exhaust gas with large quantities of air. The analysis in Section 7 of this report demonstrates the most efficient VOC control technology is not RACT for saturated emission streams with flow rates of 10 acfm. It can be concluded that VOC control technology applied to dilute VOC emission streams with flow rates of 3,600 acfm would also not be considered RACT. Therefore, the proposed RACT for Building 110 filters is consistent with 326 IAC 8-5-3(b)(2)(B).

The proposed RACT for Building 110 exposed liquid filters is fully consistent with the general RACT guidelines described in 326 IAC 8-5-3(b)(4).

9.4 *VACUUM DRYERS*

The proposed RACT for Building 110 vacuum dryers will not reduce VOC emissions. The general RACT guidelines described in IAC 326 8-5-3(b)(1) would reduce VOC emissions from Building 110 vacuum dryers by 2.00 TPY.

9.5 *AIR DRYERS*

The proposed RACT for Building 110 air dryers and filters is fully consistent with the general RACT guidelines described in IAC 326 8-5-3(b)(2)(B).

9.6 *STORAGE TANKS*

VOC emissions from storage tanks after implementation of proposed RACT would be 0.003 TPY. VOC emissions from storage tanks after implementation of the general RACT guidelines described in IAC 326 8-5-3(b)(3) would be 0.034 TPY. VOC emissions after proposed RACT would be 0.031 TPY less than VOC emissions after CTG RACT.

9.7 *IN-PROCESS TANKS*

The proposed RACT for Building 110 in-process tanks is fully consistent with the general RACT guidelines described in IAC 326 8-5-3(b)(5).

9.8 *EQUIPMENT LEAKS*

The proposed RACT for Building 110 equipment leaks is fully consistent with the general RACT guidelines described in IAC 326 8-5-3(b)(6).

10.0 OZONE ATTAINMENT PLAN IMPACTS

The following sections review the current base year inventories, and attainment and maintenance plans for the Marion County ozone non-attainment area, and present the relative impact the requested petition for a site-specific RACT standard for Lilly's facility will have in meeting SIP non-attainment area requirements.

10.1 CURRENT STATUS OF MARION COUNTY ATTAINMENT PROGRESS

The primary ambient air quality standard for ozone is attained when the expected number of days per calendar year with maximum hourly concentrations above 0.12 ppm is equal to or less than 1.0. Marion County is currently designated marginal nonattainment for ozone, having a design value of 0.118 ppm based on latest available information. A summary of measured, quality assured ambient ozone data is shown in Table 10-1, obtained from recent IAPCS documents. Based on ambient data, Marion County is attaining for the National Ambient Air Quality Standard (NAAQs) for ozone.

Table 10-1 Quality Assured Ambient Ozone Exceedances - Indianapolis Area

Site	Year	# of Days Exceedance/Year
Hamilton County, 186th Street	1987	2
Hamilton County, 186th Street	1989	1
Hancock County, Fortville	1988	1
Johnson County, 950 North Road	1987	1
Marion County, 8327 Mann Road	1988	2
Marion County, Trailer Court Road	1988	1
Marion County, Trailer Court Road	1989	1
Marion County, Trailer Court Road	1990	1
Marion County, 1321 South Harding	1987	1
Marion County, 1321 South Harding	1988	2
Marion County, 1885 North Arlington	1987	1
Marion County, 1885 North Arlington	1988	2
Morgan County, Paragon Elementary	1988	2

A request to redesignate Marion County as attainment for the ozone NAAQS was announced by IDEM in a public notice June 2, 1993. A public hearing on a proposed SIP revision and Maintenance Plan was scheduled for August 6, 1993.

10.2 *SIP EMISSION INVENTORY AND REDUCTION TARGETS*

According to *Draft Revision to the Indiana State Implementation Plan, Maintenance Plan for Ozone Attainment, Marion County* (Draft Maintenance Plan), dated July, 1993, 1990 base year VOC emissions for the expanded nonattainment area (Marion County plus other counties in a 25 mile surrounding area) were 204.6 regulatory effective tons/day from various sources apportioned as follows:

Point Sources	26.193 tons/day
Area Sources	59.350 tons/day
Non-Highway	6.640 tons/day
Mobile Sources	112.450 tons/day
Total Base Year	204.633 tons/day

Regulatory effective emissions reflect adjusted daily emissions based on number of source operating days per year and SIP required emission reductions as of November 15, 1990.

A separate base year emission inventory was performed by the IAPCS. Dated December 31, 1992 and included in Appendix D, the study reported total 1990 base year emissions of 215.24 tons/day VOCs, of which 1.70 tons/day are from all pharmaceutical manufacturing operations in the expanded nonattainment area. Revisions to the IAPCS report are being made pursuant to comments by EPA Region V concerning biogenic emission sources.

The projected VOC emission growth allowances for point sources through the year 2006, based on the Draft Maintenance Plan, is 5.063 tons/day.

Overall, the Draft Maintenance Plan predicts a net reduction in VOC emissions for the period 1990-2006 of 29.137 tons/day from all emission sources. Hence, projected total area-wide VOC emissions by the year 2006 are expected to total 175.496 tons/day, with a projected point source emission total of 31.256 tons/day.

10.3 *MARION COUNTY MAINTENANCE PLAN*

In July, 1993, the IDEM Office of Air Management drafted an ozone Maintenance Plan for Marion County. The plan, included in Appendix E, addresses the following subjects:

- Expanded non-attainment area geographic boundaries
- Identifies requirements for redesignation to attainment
- Reviews ozone monitoring network and data results
- Presents base year and future year emission inventories
- Provides a demonstration of maintenance
- Discusses controls and regulations in place
- Offers commitments for contingency measures & future controls
- Documents public participation for the Maintenance Plan
- Concludes Marion County has achieved and will maintain attainment

In summarizing results of the seven site ozone air monitoring network, the Maintenance Plan shows the last monitored ozone NAAQS violation occurred in 1988, and that future expected number of exceedances for the period 1990-92 as 0.3.

Regarding area-wide emission projections, the Draft Maintenance Plan projects a drop in total VOC emissions of 29.137 tons/day, including the effects of a growth allowance of 10.56 tons/day in point and area source emissions. The growth allowance represents 12.3% of total area VOC emissions from base year point and area sources through the year 2006, without regard to additional reductions in point source VOC emissions from the implementation of Title III MACT reductions. Estimates included in the Draft Maintenance Plan for future MACT reductions total 6.0 tons/day, or 7.01 % of point and area source base year emissions not needed to maintain attainment.

Other contingency measures which would be available to mitigate attainment shortfalls, and not committed to by the IDEM as needed for attainment include:

- Reformulated fuels or RVP controls for retail gasoline
- Stage II vapor recovery
- I/M and enhanced I/M programs
- Post 1990 RACT CTG reductions
- Lower RACT thresholds
- Transportation control measures

The Marion County Maintenance Plan and redesignation to attainment process is underway, with public hearing by the IDEM Board scheduled for August 6, 1993.

10.4 *RELATIVE IMPACT OF SITE-SPECIFIC RACT SIP REVISION ON ATTAINMENT & MAINTENANCE PLAN*

If Building 110 emission sources had been able to comply with the generalized RACT CTG for synthesized pharmaceutical products, actual emissions from the affected emission units would have been 0.033 tons/day VOCs in 1990. Under the proposed site-specific RACT plan, potential emissions would be 0.051 tons/day, based on the projected operating schedule and control measures requested in permit applications and this SIP revision. Therefore, a worst case difference of 0.018 tons/day would accrue by the approval of this SIP revision.

The worst case difference of 0.018 tons is 0.009% of 1990 base year VOC emissions of 204.633 tons/day, 0.010% of the Draft Maintenance Plan projected 2006 VOC emission target of 175.496 tons/day, and 0.057% of the projected point source total by the year 2006 of 31.256 tons/day. It also would account for 0.352% of projected point source emissions growth from the Draft Maintenance Plan of 5.063 tons/day.

Should Marion County not achieve VOC emission reduction targets as stated in the Draft Maintenance Plan, the requested SIP revision for Lilly represents only 0.391% of the combined growth allowance and expected MACT reductions of 4.56 tons/day already accounted for in the redesignation request.

Given the small relative share of the attainment plan targeted emission level for VOCs in Marion County, it is not expected that approval of a SIP revision for this site-specific RACT will generate any significant impacts that would interfere with attainment or maintenance of the ozone NAAQS.

11.0 SUMMARY OF COMPLIANCE WITH 326 IAC 8-1-5

326 IAC 8-1-5 describes the required elements of a site-specific RACT plan. The site-specific RACT plan required elements are described in detail in the previous sections of this petition. This section summarizes the petition's compliance with 326 IAC 8-1-5.

11.1 NAME AND ADDRESS OF PETITIONER

The name and address of the company and the name and telephone number of the responsible company representative over whose signature this petition is being submitted is:

Mr. Bernard O. Paul
Eli Lilly and Company
Lilly Corporate Center
Indianapolis, Indiana 46285
(317) 276-0331

for

Lilly Technical Center - South
1555 South Kentucky Avenue
Indianapolis, Indiana

This information is contained in Section 1.0 of this petition.

11.2 IDENTIFICATION AND PURPOSE OF VOC EMITTING EQUIPMENT

This petition applies to the pilot processes in Building 110 of the Lilly Technical Center - South. The pilot processes are used for chemical process research and development of pharmaceutical products. Pilot process equipment subject to this proposed RACT petition are reactors, filters, dryers, and an acetone storage tank.

Detailed descriptions of all operations conducted at this location for which this petition applies are contained in Sections 2.0 and 3.0 of this petition.

11.3 PROPOSED RACT CONTROLS

Specific operational and equipment controls for which alternative controls are proposed are summarized in Table 11.1.

Table 11.1 Proposed RACT VOC Controls

Emitting Equipment	Control Equipment	Operational Controls
Reactors	No greater than -10° C inlet working fluid primary condenser	Condenser operates when venting mixtures which will not freeze at -10° C
Centrifuges	Enclosures and filtrate discharge to vessel with -10° C primary condenser	Condenser operates when venting mixtures which will not freeze at -10° C
Filters	Enclosures and filtrate discharge to vessel with -10° C primary condenser	Condenser operates when venting mixtures which will not freeze at -10° C
Vacuum dryers	None	None
Air dryers	None	Equipment capacity and operating schedule will limit VOC emissions to not more than 33 lb/day
Equipment leaks	None	Repair when visibly leaking
Acetone storage tank	Vapor balance system	None

More detailed operation and equipment control information is contained in Sections 4.0 and 9.0 of this petition.

11.4 PROPOSED RACT IMPLEMENTATION SCHEDULE

The proposed RACT implementation schedule is summarized in Table 11.2.

Table 11.2 Proposed RACT Implementation Schedule

Emitting Equipment	Control Equipment	Operational Controls	Compliance Date
Existing reactors	-10° C primary condenser	Condenser operates during venting mixtures which will not freeze at -10° C	Implement immediately
Proposed reactors	-10° C primary condenser	Condenser operates during venting mixtures which will not freeze at -10° C	30 days after start-up
Proposed centrifuges	Enclosures and filtrate discharge to vessel with -10° C primary condenser	Condenser operates during venting mixtures which will not freeze at -10° C	30 days after start-up
Existing filters	Enclosures and filtrate discharge to vessel with -10° C primary condenser	Condenser operated during venting mixtures which will not freeze at -10° C	Implement immediately
Proposed filters	Enclosures and filtrate discharge to vessel with -10° C primary condenser	Condenser operated during venting mixtures which will not freeze at -10° C	30 days after start-up
Vacuum dryers	None	None	
Air dryers	None	Equipment capacity and operating schedule will limit VOC emissions to not more than 33 lb/day	Implement immediately
Equipment leaks	None	Repair when visibly leaking	Implement immediately
Acetone storage tank	Vapor balance system	None	Implement Immediately

11.5 PROPOSED STANDARD RACT DEMONSTRATION

11.5.1 *Capital Expenditure Required to Achieve Petitioned Level of Control*

Primary condensers on reactors are required for reflux operations and are currently in-place on existing reactors. Proposed reactors will also be equipped with primary condensers. No additional capital expenditure would be required for this element of the proposed RACT plan.

The vapor return line on the acetone tank is currently in place and would not require additional investment to implement.

11.5.2 *Impact of Cost of Petitioned Level of Control on Eli Lilly and Company*

The proposed Building 110 RACT utilizes existing equipment and good operating practices to significantly reduce VOC emissions. The cost of operating existing equipment and following existing procedures is currently incorporated into Building 110 cost structure. No additional costs would be incurred, allowing Lilly to minimize pharmaceutical manufacturing costs.

11.5.3 *Energy Requirements of Petitioned Level of Control*

Implementation of the proposed RACT would require an increase in annual electricity consumption of approximately 11,000 kilowatt-hours. This estimate was also developed using procedures in the HAP Manual.

11.5.4 *Environmental Impact of Petitioned Level of Control*

VOC pre-control emissions to the air would be reduced by approximately 10.6 TPY through implementation of the proposed level of controls. The volume of waste solvent transferred off-site for incineration would increase by approximately 10.6 TPY. No other environmental impacts are foreseen.

11.5.5 *Health and Safety Implications of Proposed Level of Control*

Implementation of the proposed level of control would not have any adverse impact on human health and safety or product safety.

11.6 CTG RACT ANALYSIS

11.6.1 *Capital Expenditure Required for CTG RACT*

An approximate capital expenditure of $1,815,462 would be required to implement CTG RACT for Building 110 processes. This estimate was developed using procedures in the condensation section of the USEPA's Handbook *Control Technologies for Hazardous Air Pollutants*, June 1991 (the HAP Manual).

Detailed capital expenditure information is contained in Section 7.0 of this petition.

11.6.2 *Impact of Cost of CTG RACT on Eli Lilly and Company*

Because of rapidly changing market forces in the pharmaceutical industry, all capital and operating expenditures are scrutinized for cost effectiveness. Research costs, such as those in the Building 110 pilot plant are increasing rapidly at a time when competitiveness and other pressures are forcing pharmaceutical companies to hold prices and costs down. Complying with the CTG RACT would require a capital expenditure of approximately $1.8 million and would result in operating expenses of $600,000 per year. Section 7 of this petition demonstrated how compliance with the CTG RACT is not a cost effective emission control strategy. Because there is great effort to reduce pharmaceutical costs, it is not prudent to employ an emission control strategy that is not cost-effective by the objective standards used in this petition.

11.6.3 *Energy Requirements for CTG RACT*

Implementation of the CTG RACT would require an increase in annual electricity consumption of approximately 17,000 kilowatt-hours. This estimate was also developed using procedures in the HAP Manual.

11.6.4 *Environmental Impact of CTG RACT*

VOC pre-control emissions to the air would be reduced by 17.23 TPY through implementation of the CTG RACT. The volume of waste solvent transferred off-site for incineration would increase by 17.23 TPY. No other environmental impact is foreseen.

11.6.5 Health and Safety Implications of CTG RACT

Implementation of the CTG RACT would not have any adverse impact on human health and safety or product safety.

APPENDIX A

SUPPORTING DOCUMENTATION FOR EMISSION CALCULATIONS

Building 110 VOC Emissions Calculation Methodology

Calculation Basis

The building 110 batch pilot plants are primarily used for chemical process research and development. The processes run in these areas are in their infancy and very dynamic. At any point in time much of the capacity is idle or in the state of setup or cleanup. Chemical processes run in the same standard equipment use various solvents, unit operations, and cycle times that are unique to each chemical compound. Because this is a new pharmaceutical chemistry and process development facility, it is not possible to project future production schedules or process parameters.

The best estimate of VOC emissions from existing and proposed process equipment should be based on the past performance of existing pilot plant equipment. The existing D-wing Batch Pilot Plant in Building 110 is comprised of 4 major modules containing 6 reactors each. The existing reactors range in size from 30 to 300 gallons; the proposed reactors will range in size from 30 to 500 gallons. Similar chemical processing, unit operations and actual equipment utilization would be expected for the expanded pilot plant areas. Emission calculations are then based on the number of batches and the batch size. The reactor capacity determines the maximum batch size. The number of batches we can process is based on historical information on the four existing 6 reactor modules in the D-wing from 1990, 1991, and 1992 (extrapolated to a full year). The estimates of VOC emissions to the air are based on physical measurements used to calculate the material balances on solvent usage for each batch run in 1991. This solvent material balance was obtained to generate the 1991 SARA 313 report for the existing facility. All solvents processed (not just SARA 313 reportable) were included in this data set. 1991 is the first entire year that solvent material balance measurements were routinely made on all batches processed in this facility.

Historical Information on Number of Batches

The number of batches per year that can be processed through a 6 reactor module is a key factor in potential annual VOC emissions. Since many different products are run through the same reactors, significant time of operation is lost due to equipment setup, tear down, and clean up between different chemical compounds. Products are typically only produced for a 1 week period, rarely more than 4 weeks for a single chemical compound.

Historical Information: Number of batches run in existing 6 reactor modules

YEAR	MODULE A	MODULE B	MODULE C	MODULE D	TOTAL
1990	46	50	30	31	157
1991	29	25	35	35	124
1992[1]	53	62	31	29	175

[1] Extrapolated from January through July batches run in 1992

Average number of batches = 38 per 6 reactor module
Standard Deviation = 11.8 batches per 6 reactor module

Probable range for the number of batches possible through a 6 reactor module in 1 year:

Confidence Interval	Minimum # Batches	Maximum # Batches
90% (1.645 x Std. Dev.)	19	57
95% (1.96 x Std. Dev.)	15	61
99.8% (3.08 x Std. Dev.)	2	74

It is very unlikely that we could exceed 80 batches/year of production through a 6 reactor module in a research and development area which requires frequent changeovers.

Equipment Sizing Information

The existing Batch Pilot Plant reactor capacity available in the four major modules of the pilot plant is:

Reactor #	Module A	Module B	Module C	Module D
1	100 glass	50 glass	50 stainless	100 glass
2	100 stainless	100 glass	200 glass	200 glass
3	200 glass	100 stainless	100 glass	300 glass
4	200 hastelloy	50 glass	100 stainless	200 glass
5	100 glass	200 glass	200 stainless	300 glass
6	300 glass	200 glass	200 glass	300 glass
Totals:	1000 gallons	700 gallons	850 gallons	1400 gallons

Grand Total: 3950 gallons of reactor capacity

Historical Solvent Usage Information

The 1991 calendar year was the first full year that detailed material balance data was obtained on all solvent usage for each process in the pilot plant. This information was used to submit the 1991 SARA 313 report for the existing facility. This data represents typical processing which occurs in this Research and Development facility; future work in the expanded facility is expected to be of a similar nature. Note that these numbers represent the solvent usage for chemical processing and cleaning of the equipment between batches. The additional VOCs for the building from heat transfer systems, solvent waste systems, etc. are not included in these numbers. Emissions from the heat transfer systems are negligible. The existing solvent waste system will not be altered and is covered in the existing operating permit application.

Gross Usage	422,435 lbs
Saved[2]	29,340 lbs
Reacted	40 lbs
Incinerated	380,845 lbs
Fugitive	11,090 lbs
Point Source	1,120 lbs
Total to Air:	12,210 lbs (fugitive + point source)

Overall Percentage of total usage to air: 2.9%

[2] For example, mother liquor held in inventory for future recovery

The best prediction for overall gross usage of solvent for the additional reactor capacity is based on the following data:

$$\frac{\text{422,435 lb gross usage annually}}{\text{(29 batches)(1000 gal)+(25 batches)(700 gal)+ (35 batches)(850 gal)+(35 batches)(1400 gal)}}$$

$$= \frac{\text{3.37 lb gross solvent used}}{\text{(batch)(gallon of reactor capacity)}}$$

Incorporating the overall percent usage to air of 3%, the total amount of solvent emitted to the air annually would be:

$$\frac{\text{3.37 lb gross solvent used } \times 0.03}{\text{(batch)(gallon of reactor capacity)}}$$

$$= \frac{\text{0.101 lb gross solvent emitted to the air}}{\text{(batch)(gallon of reactor capacity)}}$$

Allocation of VOCs to Various Pieces of Process Equipment

The overall solvent material balances give the total amount of solvent lost to the atmosphere. The total VOCs emitted needs to be allocated to process equipment or unit operations.

Dryer Emissions:

1,120 lbs of solvent vapor were discharged from dryer vents in 1991 from the existing D-wing facility. Once again, the dryer vent discharge should be affected by the number of batches and the batch size. The best prediction for overall dryer vent emissions for the additional reactor capacity is based on the following data:

$$\frac{\text{1,120 lb solvent out of dryer vents}}{\text{(29 batches)(1000 gal)+(25 batches)(700 gal)+ (35 batches)(850 gal)+(35 batches)(1400 gal)}}$$

$$= \frac{\text{8.94 x 10-3 lb solvent out of dryer vents}}{\text{(batch)(gallon of reactor capacity)}}$$

Filtration/Centrifugation Emissions:

Data from a recent pilot plant campaign in the existing C-Wing is presented which involved the use of a 75 gallon reactor, 35" single plate filter, and 62 gallon filtrate receiver.

Batch Number	Total Mass Charged, kgs	Total Mass
Removed, kgs		
Stoichiometry "A"		
102PB2	227.83	231.09
103PB2	227.17	230.13
105LB2	226.93	226.42
106PB2	227.93	226.76
Average "A"	227.47	228.60
Out-In = +1.14 kg		
Stoichiometry "B"		
107PB2	237.53	237.37
108PB2	236.83	235.76
109PB2	239.53	240.12
110PB2	236.95	235.371
11PB2	238.19	239.77
112PB2	238.13	241.15
Average "B"	237.86	238.26
Out-In = +0.40 kg		

These data include all "wet" processing prior to drying, including charging, reacting at reflux, filtration, and washing of the product cake. As such, they require multiple weighings of the entire reaction vessel, and the weights of the individual components added. Each reactor weighing is accurate to +\- 0.2 kgs, while the accuracy of the weights of individual reagents varied between +\- 0.2 to +\- 0.002 kg (depending on quantity of reagent required). The total uncertainty for the entire series of measurements is +\- 1.76 kgs. As can be seen, all measurements were within the uncertainty of the measurement, indicating a very low loss of VOCs through this point of processing. The estimate for the amount of VOC lost for each filtration or centrifugation operation will be taken as 5 lbs per operation.

The VOCs attributed to filtration and centrifugation equipment are based on the following assumptions:

- 5 lbs of VOC per solids isolation
- 2 solids isolation per batch

Per module, this leads to

$$\frac{\text{10 lbs solvent emitted from filters / centrifuges}}{\text{(batch)}}$$

Fugitive Emissions:

Fugitive emissions were estimated using emission factors in the USEPA's *Protocols for Generating Unit-Specific Emission Estimates for Equipment Leaks of VOC and VHAP*. The number of each type of fugitive emission source (valves, flanges, pump seals, etc.) in each module were estimated. The estimates were then multiplied by the appropriate emission factor in Table 2-1 of the Protocols. The fugitive emissions calculations are summarized on the worksheets in Appendix B of the report.

Reactor Emissions:

Finally, to close the material balance, emissions will be assigned to the reactor vents.

Reactor emissions = (Total emissions - dryer emissions - filtration emissions - fugitive emissions)

Sample Calculations

The following calculations are the basis for the emissions estimates for existing and proposed Building 110 pilot process equipment.

Maximum processing capability of each module:

80 batches/year

Total amount of solvent emitted to the air per batch per gallon of reactor capacity annually:

Equation A:
$$\frac{\text{0.101 lbs solvent emitted to the air}}{\text{(batch)(gallon of reactor capacity)}}$$

VOCs emitted to the air to the various types of equipment in each module:

Dryer emissions for the module:

Equation B:
$$\frac{\text{0.00894 lbs solvent out of dryer vents}}{\text{(batch)(gallon of reactor capacity)}}$$

Filtration/Centrifugation emissions for the module:

Equation C:
$$\frac{\text{10 lbs solvent emitted out of filter/centrifuge vents}}{\text{(batch)}}$$

Fugitive emissions for the module:

Quantity of equipment * emission factor

(See worksheets in Appendix B for calculations)

Reactor emissions for the module:

Equation D: Total solvent emitted annually - dryers emissions - filtration/centrifugation emissions - fugitive emissions

Pre-Control Potential Emissions Calculations (TPY) from Existing and Proposed Building 110 Process Equipment

Module	Batch/ yr	Reactor Capacity	Total Emissions	Dryer Emissions	Fltr/Cntrfg Emissions	Fugitive[1] Emissions	Reactor Emissions
Column	E	F	H	I	J	K	
Equation			EqA*E*F/2000	EqB*E*F/2000	EqC*E/2000		H-I-J-K
A	80	1,000	4.04	0.36	0.40	1.02	2.26
B	80	700	2.83	0.25	0.40	1.02	1.16
C	80	850	3.43	0.30	0.40	1.02	1.71
D	80	1,400	5.65	0.50	0.40	1.02	3.73
E	80	1,300	5.24	0.46	0.40	1.02	3.36
F	80	1,300	5.24	0.46	0.40	1.02	3.36
30 Gallon-A	80	123	0.49	0.04[2]	0.20[3]	0.14	0.11
30 Gallon-B	80	110	0.45	0.04[2]	0.20[3]	0.11	0.10
C-Wing	80	480	1.94	0.18	0.40	0.57	0.79
Total			29.31	2.59	3.20	6.94	16.58

Notes:

1. Estimated using USEPA emission factors.
2. For the vacuum pump associated with existing dryer VDS-696.
3. Emission factor adjusted for small batch size.

APPENDIX B

EMISSION STREAMS CHARACTERIZATION CALCULATIONS

Pre-Control Emissions Summary
Eli Lilly and Company
Building 110

Module:	A	
Module emission factor:	0.101	(lb VOC)/((lot) (gallon of reactor capacity))
Filtration emission factor:	10	(lb VOC)/(lot)
Dryer emission factor:	0.00894	(lb VOC)/((lot) (gallon of reactor capacity))
Number of reactors:	6	
Total reactor capacity:	1,000	(gallon)
Maximum lots per year:	80	
Approximate hours per lot:	32	
Total emissions per lot:	101	(lb VOC)

Fugitive emissions components per module

Valves:	30	**Open ended lines:**	6
Flanges:	150	**Sampling connections:**	6
Pump Seals:	3	**Press relief seals:**	6
Comp. Seals:	0		

Component utilization:	30%	
Fugitive emissions*:	1.02	(TPY)
·tal emissions:	4.04	(TPY)
Emissions stream temp:	77	(degree F)

Emissions Source	Emissions (TPY)	Duration (hr)	Average Emissions (lb/hr)	Average Emissions (lb/lot)	Minimum Emissions Stream Flow (acfm)	Maximu Emissic Strean Flow (acfm)'
Reactors	2.26	24	2.35	56.51	1.12	1
Filter/Centrifuge	0.40	2	5.00	10.00	2.37	1
Dryer	0.36	6	1.49	8.94	0.71	1
Fugitive	1.02	30	0.85	25.55	NA	N
Total	4.04	32		101.00		

* Using emission factors in USEPA, "Protocols for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP"

** Conservatively (low) estimate based on vacuum pump performance

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Pre-Control Emissions Summary
Eli Lilly and Company
Building 110

Module:	B	
Module emission factor:	0.101	(lb VOC)/((lot) (gallon of reactor capacity))
Filtration emission factor:	10	(lb VOC)/(lot)
Dryer emission factor:	0.00894	(lb VOC)/((lot) (gallon of reactor capacity))
Number of reactors:	6	
Total reactor capacity:	700	(gallon)
Maximum lots per year:	80	
Approximate hours per lot:	32	
Total emissions per lot:	70.7	(lb VOC)

Fugitive emissions components per module

Valves:	30	**Open ended lines:**	6
Flanges:	150	**Sampling connections:**	6
Pump Seals:	3	**Press relief seals:**	6
Comp. Seals:	0		

Component utilization:	30%	
Fugitive emissions*:	1.02	(TPY)
Total emissions:	2.83	(TPY)
Emissions stream temp:	77	(degree F)

Emissions Source	Emissions (TPY)	Duration (hr)	Average Emissions (lb/hr)	Average Emissions (lb/lot)	Minimum Emissions Stream Flow (acfm)	Maximum Emission Stream Flow (acfm)**
Reactors	1.16	24	1.20	28.89	0.57	10
Filter/Centrifuge	0.40	2	5.00	10.00	2.37	10
Dryer	0.25	6	1.04	6.26	0.50	10
Fugitive	1.02	30	0.85	25.55	NA	NA
Total	**2.83**	32		**70.70**		

* Using emission factors in USEPA, "Protocols for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP"

** Conservatively (low) estimate based on vacuum pump performance

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Pro-Control Emissions Summary
Eli Lilly and Company
Building 110

Module:	C	
Module emission factor:	0.101	(lb VOC)/((lot) (gallon of reactor capacity))
Filtration emission factor:	10	(lb VOC)/(lot)
Dryer emission factor:	0.00894	(lb VOC)/((lot) (gallon of reactor capacity))
Number of reactors:	6	
Total reactor capacity:	850	(gallon)
Maximum lots per year:	80	
Approximate hours per lot:	32	
Total emissions per lot:	85.85	(lb VOC)

Fugitive emissions components per module

Valves:	30	**Open ended lines:**	6
Flanges:	150	**Sampling connections:**	6
Pump Seals:	3	**Press relief seals:**	6
Comp. Seals:	0		

Component utilization:	30%	
Fugitive emissions*:	1.02	(TPY)
'tal emissions:	3.43	(TPY)
Emissions stream temp:	77	(degree F)

Emissions Source	Emissions (TPY)	Duration (hr)	Average Emissions (lb/hr)	Average Emissions (lb/lot)	Minimum Emissions Stream Flow (acfm)	Maximum Emission Stream Flow (acfm)**
Reactors	1.71	24	1.78	42.70	0.84	10
Filter/Centrifuge	0.40	2	5.00	10.00	2.37	10
Dryer	0.30	6	1.27	7.60	0.60	10
Fugitive	1.02	30	0.85	25.55	NA	NA
Total	3.43	32		85.85		

* Using emission factors in USEPA, "Protocols for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP"

** Conservatively (low) estimate based on vacuum pump performance

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06-Dec-!

Pre-Control Emissions Summary
Eli Lilly and Company
Building 110

Module: D
Module emission factor: 0.101 (lb VOC)/((lot) (gallon of reactor capacity))
Filtration emission factor: 10 (lb VOC)/(lot)
Dryer emission factor: 0.00894 (lb VOC)/((lot) (gallon of reactor capacity))
Number of reactors: 6
Total reactor capacity: 1,400 (gallon)
Maximum lots per year: 80
Approximate hours per lot: 32
Total emissions per lot: 141.4 (lb VOC)

Fugitive emissions components per module

Valves:	30	**Open ended lines:**	6
Flanges:	150	**Sampling connections:**	6
Pump Seals:	3	**Press relief seals:**	6
Comp. Seals:	0		

Component utilization: 30%
Fugitive emissions*: 1.02 (TPY)
Total emissions: 5.66 (TPY)
Emissions stream temp: 77 (degree F)

Emissions Source	Emissions (TPY)	Duration (hr)	Average Emissions (lb/hr)	Average Emissions (lb/lot)	Minimum Emissions Stream Flow (acfm)	Maximum Emission Stream Flow (acfm)**
Reactors	3.73	24	3.89	93.33	1.85	10
Filter/Centrifuge	0.40	2	5.00	10.00	2.37	10
Dryer	0.50	6	2.09	12.52	0.99	10
Fugitive	1.02	30	0.85	25.55	NA	NA
Total	5.65	32		141.40		

* Using emission factors in USEPA, "Protocols for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP"

** Conservatively (low) estimate based on vacuum pump performance

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06-Dec-9

Pre-Control Emissions Summary
Eli Lilly and Company
Building 110

Module:	E	
Module emission factor:	0.101	(lb VOC)/((lot) (gallon of reactor capacity))
Filtration emission factor:	10	(lb VOC)/(lot)
Dryer emission factor:	0.00894	(lb VOC)/((lot) (gallon of reactor capacity))
Number of reactors:	6	
Total reactor capacity:	1,300	(gallon)
Maximum lots per year:	80	
Approximate hours per lot:	32	
Total emissions per lot:	131.3	(lb VOC)

Fugitive emissions components per module

Valves:	30	**Open ended lines:**	6
Flanges:	150	**Sampling connections:**	6
Pump Seals:	3	**Press relief seals:**	6
Comp. Seals:	0		

Component utilization:	30%	
Fugitive emissions*:	1.02	(TPY)
Total emissions:	5.25	(TPY)
Emissions stream temp:	77	(degree F)

Emissions Source	Emissions (TPY)	Duration (hr)	Average Emissions (lb/hr)	Average Emissions (lb/lot)	Minimum Emissions Stream Flow (acfm)	Maximum Emission Stream Flow (acfm)**
Reactors	3.36	24	3.51	84.12	1.66	10
Filter/Centrifuge	0.40	2	5.00	10.00	2.37	10
Dryer	0.46	6	1.94	11.62	0.92	10
Fugitive	1.02	30	0.85	25.55	NA	NA
Total	5.24	32		131.30		

* Using emission factors in USEPA, "Protocols for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP"

** Conservatively (low) estimate based on vacuum pump performance

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06-Dec-9

Pre-Control Emissions Summary
Eli Lilly and Company
Building 110

Module:	F	
Module emission factor:	0.101	(lb VOC)/((lot) (gallon of reactor capacity))
Filtration emission factor:	10	(lb VOC)/(lot)
Dryer emission factor:	0.00894	(lb VOC)/((lot) (gallon of reactor capacity))
Number of reactors:	6	
Total reactor capacity:	1,300	(gallon)
Maximum lots per year:	80	
Approximate hours per lot:	32	
Total emissions per lot:	131.3	(lb VOC)

Fugitive emissions components per module

Valves:	30	**Open ended lines:**	6
Flanges:	150	**Sampling connections:**	6
Pump Seals:	3	**Press relief seals:**	6
Comp. Seals:	0		

Component utilization:	30%	
Fugitive emissions*:	1.02	(TPY)
Total emissions:	5.25	(TPY)
Emissions stream temp:	77	(degree F)

Emissions Source	Emissions (TPY)	Duration (hr)	Average Emissions (lb/hr)	Average Emissions (lb/lot)	Minimum Emissions Stream Flow (acfm)	Maximum Emission Stream Flow (acfm)**
Reactors	3.36	24	3.51	84.12	1.66	10
Filter/Centrifuge	0.40	2	5.00	10.00	2.37	10
Dryer	0.46	6	1.94	11.62	0.92	10
Fugitive	1.02	30	0.85	25.55	NA	NA
Total	**5.24**	**32**		**131.30**		

* Using emission factors in USEPA, "Protocols for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP"

** Conservatively (low) estimate based on vacuum pump performance

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06-Dec-93

Pre-Control Emissions Summary
Eli Lilly and Company
Building 110

Module:	30 Gallon-A	
Module emission factor:	0.101	(lb VOC)/((lot) (gallon of reactor capacity))
Filtration emission factor*:	5	(lb VOC)/(lot)
Dryer emission factor:	0.00894	(lb VOC)/((lot) (gallon of reactor capacity))
# of reactors & evaporators:	4	
Total reactor capacity:	123	(gallon)
Maximum lots per year:	80	
Approximate hours per lot:	32	
Total emissions per lot:	12.42	(lb VOC)

Fugitive emissions components per module

Valves:	15	**Open ended lines:**	2
Flanges:	75	**Sampling connections:**	2
Pump Seals:	1	**Press relief seals:**	0
Comp. Seals:	0		

Component utilization:	20%	
Fugitive emissions**:	0.14	(TPY)
tal emissions:	0.50	(TPY)
Emissions stream temp:	77	(degree F)

Emissions Source	Emissions (TPY)	Duration (hr)	Average Emissions (lb/hr)	Average Emissions (lb/lot)	Minimum Emissions Stream Flow (acfm)	Maximum Emission Stream Flow (acfm)***
Reactors	0.11	24	0.12	2.78	0.06	10
Filter/Centrifuge	0.20	2	2.50	5.00	1.19	10
Dryer	0.04	6	0.18	1.10	0.09	10
Fugitive	0.14	30	0.12	3.54	NA	NA
Total	0.49	32		12.42		

* Emission factor adjusted for small lot size

** Using emission factors in USEPA, "Protocols for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP"

*** Conservatively (low) estimate based on vacuum pump performance

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06-Dec-'

Pre-Control Emissions Summary
Eli Lilly and Company
Building 110

Module:	30 Gallon-B	
Module emission factor:	0.101	(lb VOC)/((lot) (gallon of reactor capacity))
Filtration emission factor*:	5	(lb VOC)/(lot)
Dryer emission factor:	0.00894	(lb VOC)/((lot) (gallon of reactor capacity))
Number of reactors:	3	
Total reactor capacity:	110	(gallon)
Maximum lots per year:	80	
Average hours per lot:	32	
Total emissions per lot:	11.11	(lb VOC)

Fugitive emissions components per module

Valves:	10	**Open ended lines:**	2
Flanges:	50	**Sampling connections:**	2
Pump Seals:	1	**Press relief seals:**	0
Comp. Seals:	0		

Component utilization:	20%	
Fugitive emissions:**	0.11	(TPY)
tal emissions:	0.44	(TPY)
Emissions stream temp:	77	(degree F)

Emissions Source	Emissions (TPY)	Duration (hr)	Average Emissions (lb/hr)	Average Emissions (lb/lot)	Minimum Emissions Stream Flow (acfm)	Maximum Emission Stream Flow (acfm)***
Reactors	0.10	24	0.10	2.38	0.05	10
Filter/Centrifuge	0.20	2	2.50	5.00	1.19	10
Dryer	0.04	6	0.16	0.98	0.08	10
Fugitive	0.11	30	0.09	2.75	NA	NA
Total	0.45	32		11.11		

* Emission factor adjusted for small lot size

** Using emission factors in USEPA, "Protocols for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP"

*** Conservatively (low) estimate based on vacuum pump performance

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06-Dec-9

Pre-Control Emissions Summary
Eli Lilly and Company
Building 110

Module:	C-Wing	
Module emission factor:	0.101	(lb VOC)/((lot) (gallon of reactor capacity))
Filtration emission factor:	10	(lb VOC)/(lot)
Dryer emission factor:	0.00894	(lb VOC)/((lot) (gallon of reactor capacity))
Number of reactors:	18	
Total reactor capacity:	480	(gallon)
Maximum lots per year:	80	
Approximate hours per lot:	32	
Total emissions per lot:	48.48	(lb VOC)

Fugitive emissions components per module

Valves:	30	**Open ended lines:**	12
Flanges:	200	**Sampling connections:**	12
Pump Seals:	2	**Press relief seals:**	0
Comp. Seals:	0		

Component utilization:	30%	
Fugitive emissions*:	0.57	(TPY)
tal emissions:	1.94	(TPY)
Emissions stream temp:	77	(degree F)

Emissions Source	Emissions (TPY)	Duration (hr)	Average Emissions (lb/hr)	Average Emissions (lb/lot)	Minimum Emissions Stream Flow (acfm)	Maximum Emission Stream Flow (acfm)**
Reactors	0.79	24	0.82	19.77	0.39	10
Filter/Centrifuge	0.40	2	5.00	10.00	2.37	10
Dryer	0.18	6	0.73	4.39	0.35	10
Fugitive	0.57	30	0.48	14.32	NA	NA
Total	1.94	32		48.48		

* Using emission factors in USEPA, "Protocols for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP"

** Conservatively (low) estimate based on vacuum pump performance

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06-Dec-

APPENDIX C

ADD-ON CONTROL COST CALCULATIONS

BACT Calculation Input Parameters

Project Description: Eli Lilly

Process Description: Building 110 Expansion - Module E

Avg. Emission stream flow, Qe:	10	(acfm)
Stream pressure, P:	1.0	(atm)
Stream temperature, Te:	77	(F)
Relative humidity, Rhum:	50	(%)
Air pollutant, HAP:	VOC	
Annual emissions rate, ER:	3.38	(tons/year)
HAP molecular weight, M:	70.87	(lb/lb mole)
Halogenated hydrocarbons present:	N	(Y or N)
Emission stream LEL, LEL:	1,200	(ppmv) Table 4.2-1
No. adsorb carbon beds, NA:	1	
No. desorb carbon beds, ND:	1	
Operating hours/year, HRS:	2,560	(hours)
Operating labor cost:	$30.00	($/hr)
Maintenance labor cost:	$30.00	($/hr)
Regeneration steam req., St:	1.0	(#stm/#crbn) Table 4.6-2
Adsorp cycle time, Oad:	2	(hour) Table 4.6-2
Regen. cycle time, Oreg:	2	(hour) Table 4.6-2
Dry-cool cycle time, Odc:	15	(min) Page 4-34
Bed stream velocity, Ue:	100	(ft/min) Page 4-32
HAP heat content:	17,000	(BTU/lb)
Carbon Adsorp removal effic, RE:	95	(%)
Therm incin removal effic, RE:	95	(%)
Cat incin removal effic, RE:	95	(%)
Most recent CE cost index:	358.6	
Month & year of above CE index:	April, 1992	
Temp. for 1 mm Hg vapor pressure:	-48.13	(Deg C) Perry Table 3-8
Temp. for 100 mm Hg vapor pressure	19.93	(Deg C) Perry Table 3-8
Heat of Vaporization at Tcon, dH	10	(Btu/lb) Perry Fig 3-9
HAP Spec Ht at condense temp range.	0.153	(cal / g C) Perry Table 3-177

Auxiliary Equipment Cost:	$25,000	($) Aux equip cost
Material cost factor, Fm:	1.0	From Table 4.6-4
Cost of building, Bldg:	$0	Or Enter CALC to use Percent of Eq. Cost
Bldg Cost as % of Equipt. Cost:	0.0%	Typically 3% to 9% (Perry's p. 2521)
Steam price, Ps:	$6.110	($/1000 lbs)
Cooling water cost, Pcw:	$0.200	($/1000 gals) From Table 4.6-7
Electricity cost:	$0.059	($/kWh)
Cost of activated carbon, Cc:	$2.330	($/lb)
Natural gas price:	$3.550	($/1000 scf)
Base or precious metal catalyst:	PM	(Enter "BM" or "PM")
Cost of PM catalyst:	$3,000	($/ft3)
Cost of BM catalyst:	$775	($/ft3)
Density of flue gas, De:	0.074	(lb/scf) From Page 4-5
Density of fuel gas, Df:	0.041	(lb/scf) From Page 4-5
Mean heat capacity of air, Cp:	0.019	(BTU/scf F) From Table C.5-1
Stream oxygen content:	20.6	(%)
Reference temperature, Tr:	77	(deg F)
Lower heat value of nat. gas:	21,503	(BTU/lb) From Page 4-14
Heat x eff, thrml rec & Cat/ox, HR:	70	(%)
Heat xchngr effic, thrml reg, HR:	95	(%)
Heat xchngr effic, cat incin, HR:	70	(%)
Value of recovered HAP, Vhap:	($0.032)	($/lb)
Max desired stream heat cont, hd:	13	(BTU/scf)
Capital recovery factor, CRF:	0.1627	(10 years at 10.0%)
CE cost index for base year:	340.1	April 1988
Cost of site prep, SP:	$0	($)
Interest Rate:	10.0%	(Percent)
Peak Emission Flow Rate:	10	(scfm)
Refrigerator Efficiency, Er:	65	(Percent)

Worksheet for Costing
Condensation
Control Technology

Building 110 Expansion - Module E

HAP heat content:	17,000	(BTU/lb)
Molecular weight of HAP, MWhap:	70.87	(lb/lb mole)
Emission Stream Flow, Qea:	10.0	(acfm)
Emission stream flow, Qe:	10.0	(scfm)
Stream pressure, P:	1	(atm)
Stream temperature, Te:	77	(F)
Total Coolant Required, QCtot:	200	(gal)
Maximum HAP conc., HAPe:	185034	(ppmv)
Removal efficiency, RE:	96.3	(%)
Heat Transfer Coefficient, U:	20.0	(BTU/hr ft^2 DegF)
System Pressure Drop, P:	5.0	(in)
Temp. for 1 mm Hg vapor pressure:	-54.634	(Deg F)
Temp. for 100 mm Hg vapor pressure:	67.874	(Deg F)
Operating hours/year, HRS:	2,560	(hours)
Heat exchanger efficiency, HR:	95	(%)

System Pressure Drop, Psys:	5	(in)
Coolant Pump Motor Efficiency, n:	0.85	(dimensionless)
Peak/Average Flow Ratio:	1.00	(scfm/scfm)
Minimum Coolant Velocity:	3.0	(ft/s)
Coolant Tube Diameter:	0.375	(in)
Coolant Specific Heat:	0.65	(Btu/lb-DegF)
Coolant Specific Gravity, Sg:	7.48	(lb/gal)
Cooling Liquid Cost, UScool:	7.6	($/gal) From Vendor
Auxiliary equipment cost, AEC:	$25,000	($) Fan, ductwork, stack, & damper
Cost of building, Bldg:	$0	Set by input parameter
Cost of site prep, SP:	$0	($)
Electricity cost, USelec:	$0.059	($/kWh) From Table 4.6-7
Operating labor cost:	$30.00	($/hour) From Table 4.3-6, * 358.6/340.1
Maintenance labor cost:	$30.00	($/hour) From Table 4.3-6 * 358.6/340.1
Refrigerator Efficiency, Er:	65	(Percent)

Calculate Ppartial of HAP in outlet stream:		6.33	(mm Hg) 760*(1-0.01*RE)/(1-RE*1.0E-08*HAPe)*HAPe*1.0E-06
Condensation Curve Xint, Xint:		0.00247	(1/Deg R) 1 / (Xint + 460)
Condensation Curve Slope, CSl:		0.00029	(DegR mm Hg) -1/ (Tcon 100mm Hg + 460)+Xint)/2
Calculate Tcon:	-25.04	-13.1	(Deg F) 1 / (Xint - CSl * LOG(Pvapor)) - 460
Composition of coolant:		DOWTHERM	IF Tcon > 60, WATER; IF 45 < Tcon < 60, CHILLED WATER; IF -30 < Tcon < 45, DOWTHERM; IF Tcon < -30, FREON.
Moles HAP in inlet emission stream /min, HAPem:		0.00472	(lb-moles/min) Qe/392 * HAPe * 1.0E-06
Moles HAP in outlet emission stream/min, HAPom:		0.00017	(lb-moles/min) Qe/392 * (1 - HAPe * 1.0E-06) * Pvapor / (Pe - Pvapor)
Moles HAP condensed/min, HAPcon:		0.00455	(lb-moles/min) HAPem - HAPom
HAP heat of vaporization at Tcon, dH:		709	(Btu/lb-mole)
HAP avg spec. heat for temp Tcon to Te, CPhap:		10.84311	(Btu/lb-mole-degF)
Enthalpy change of condensed HAP, Hcon:		7.66	HAPcon [dH + CPhap + (Te - Tcon)]
Enthalpy change of air, Hnoncon:		13.20	[(Qe/392) - HAPem] CPair (Te - Tcon)
Condenser Heat Load, Hload:		1377	(Btu/hr) 1.1 * 60 * (Hcon + Hnoncon)
Coolant Input Temperature, Tcooli:		-28.1	(Deg F) Tcon - 15
Coolant Output Temperature, Tcoolo:		-3.1	(Deg F) Tcooli + 25
Log Mean Temp Difference, DTlm:		38.9	(Deg F) (Te - Tcoolo - 15)/ LN ((Te - Tcoolo)/15)
Area of Condenser, Acon:		1.77	(ft^2) Hload * (PkFlow/AvgFlow) / (U * DTlm)
Average Spec Heat of Coolant, CPcoolant:		0.65	(Btu/lb DegF)
Coolant Flow Rate, Qcool:		590	(lb/hr) MAX(Hload / (CPcoolant (Tcoolo - Tcooli) , Fmin * Td^2 * Dens * 7.48 gal/ft^3 * 3600 s/hr)
Total Coolant Required, QCtot:		200	(gal) Estimate by Project Engineer
Refrigeration Capacity, Ref:		0.11	(tons) Hload * (PkFlow/AvgFlow) / 12000
Recovered Product, Qrec:		19.33	(lb/hr) 60 * HAPcon * MWhap

CAPITAL COSTS

Calc Refrigeration Capital Cost, RCC:	$28,919	From Table 4.8-4, corrected to April, 1992 dollars
Calculate Condenser Capital Cost, CCC:	$5,838	From Figure 4.8-3, corrected to April, 1992 dollars
Cost of Cooling Liquid, TScool:	$1,520	($) QCtot * UScool
Auxiliary Equipment Cost, AEC:	$25,000	($) Parameter
Calculate Purchased Equipment Cost, PEC:	$73,530	($) 1.20* (RCC + CCC + TScool + AEC)
Building Cost, Bldg:	$0	(0.0% of purchased equipment cost)
Site Preparation, SP:	$0	
Calculate Total Capital Cost, TCC:	$127,942	1.81 * PEC + SP + Bldg

Worksheet for Costing
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Building 110 Expansion - Module E

DIRECT ANNUAL COSTS

System Pressure Drop, Psys:	5	(in) Parameter
Determine fan power requirement, Fp:	23	(kWh/yr) 1.81E-04 * Qes * P * HRS
Determine refrigeration power requirement, Rp:	1588.88	(KWh/yr) Hload * HRS * 2.93E-04 kWh/Btu / Er
Determine coolant pumping requirement, Pp:	245.32	(KWh/yr) [2.52 E-04 * Qcool/60/Sg * H * Sg/7.48 / n] * HRS * 0.746 From Table 4.6-6 of HAP Manual
Calculate annual electricity cost:	$110	($) USelec * (Fp + Rp + Pp)
Cost of Refrigerant:	$0	($) set to zero
Operating costs:		
a) Operating labor costs:	$4,800	[(0.5 hr/shift)/(8 hr/shift)] (HRS)($hourly rate)
b) Supervisory costs:	$720	0.15 (Operating labor costs)
Maintenance costs:		
a) Maintenance labor costs:	$4,800	[(0.5 hr/shift)/(8 hr/shift)] (HRS)($hourly rate)
b) Maintenance materials:	$4,800	1.0 (Maintenance labor costs)
Disposal of Recovered HAP:	$208	($) -Vhap * ER * 2000 * RE
TOTAL DIRECT ANNUAL COSTS:	$15,438	

INDIRECT ANNUAL COSTS

Overhead:	$9,072	0.60 (Operating + maintenance)
Property tax:	$1,279	1 percent of TCC
Insurance:	$1,279	1 percent of TCC
Administrative:	$2,559	2 percent of TCC
Capital recovery:	$20,822	CRF * TCC
TOTAL INDIRECT COSTS:	$35,012	
TOTAL ANNUAL COSTS:	$50,450	
COST PER TON CONTROLLED:	$15,499	($/ton HAP controlled)

Eli Lilly

Building 110 Expansion - Module E
CONDENSATION
ANNUAL COSTS

COST ITEM	FACTOR	UNIT COST	COST(*)
DIRECT ANNUAL COSTS(**)			
Operating Labor			
Operator (hrs.)	0.5 hr/shift	0.00/hr.	$4,800
Supervisor	15% of operator		720
Operating Materials			
Maintenance			
Labor (hrs.)	0.5 hr/shift	0.00/hr.	4,800
Material	100% of Maint. Labor		4,800
Utilities			
Refrigerant			0
Electricity		0.059/kWh	110
TOTAL DIRECT COSTS			$15,438
INDIRECT ANNUAL COSTS			
Overhead	60% of sum of operating, supervisor and maintenance labor, and maintenance materials.		9,072
TCI(***)	$127,942		
Administrative Charges	2% TCI		2,559
Property Taxes	1% TCI		1,279
Insurance	1% TCI		1,279
Capital Recovery Cost Factor (****)	0.1627		
Capital Recovery	CRF x TCI		20,822
TOTAL INDIRECT COSTS			$35,012
TOTAL ANNUAL COST			$50,450

NOTES:
(*) April, 1992 Dollars
(**) Assumes 2560 hr/yr.
(***) Total Capital Investment, from corresponding Capital Costs Table.
(****) Capital Recovery Cost Factor (CRF) (10 years at 10.0%)
CRF = 0.1627

Eli Lilly

Building 110 Expansion - Module E
CONDENSATION
CAPITAL COSTS

COST ITEM	COST (*)
DIRECT COSTS	
Purchased Equipment Costs	
Refrigeration Capital Cost	$28,919
Condenser Capital Cost	5,836
Auxiliary Equipment	25,000
Cooling Liquid Cost	1520
Total Equipment Cost (A)	$61,275
Instrumentation (0.10A)	6,127
Sales Taxes (0.05A)	3,064
Freight (0.05A)	3,064
Purchased Equipment Costs (B)	$73,530
Direct Installation Costs	
Foundation and supports (0.08B)	5,882
Handling and erection (0.14B)	10,294
Electrical (0.08B)	5,882
Piping (0.02B)	1,471
Insulation for Ductwork (0.10B)	7,353
Painting (0.01B)	735
Direct Installation Cost (C)	$31,618
Site Preparation (**)(D)	0
Buildings (E)	0
TOTAL DIRECT COSTS (B) + (C) + (D) + (E)	$105,148
INDIRECT COSTS (Installation)	
Engineering (0.10B)	7,353
Construction and field expense (0.05B)	3,676
Contractor Fees (0.10B)	7,353
Start-Up (0.02B)	1,471
Performance Test (0.01B)	735
Contingencies (0.03B)	2,206
TOTAL INDIRECT COSTS	$22,794
TOTAL CAPITAL INVESTMENT (TCI)	$127,942

NOTES:
(*) April, 1992 Dollars
(**) As required; disregarded for calculation purposes

BACT Calculation Input Parameters

Project Description: Eli Lilly

Process Description: Building 110 Expansion - Module E

Avg. Emission stream flow, Qe:	10	(scfm)	Auxiliary Equipment Cost:	$25,000	($) Aux equip cost
Stream pressure, P:	1.0	(atm)	Material cost factor, Fm:	1.0	From Table 4.8-4
Stream temperature, Te:	77	(F)	Cost of building, Bldg:	$0	Or Enter CALC to use Percent of Eq. Cost
Relative humidity, Rhum:	50	(%)	Bldg Cost as % of Equipt. Cost:	0.0%	Typically 3% to 9% (Perry's p. 2521)
Air pollutant, HAP:	VOC		Steam price, Ps:	$6.110	($/1000 lbs)
Annual emissions rate, ER:	4.22	(tons/year)	Cooling water cost, Pcw:	$0.200	($/1000 gals) From Table 4.6-7
HAP molecular weight, M:	70.87	(lb/lb mole)	Electricity cost:	$0.059	($/kWh)
Halogenated hydrocarbons present:	N	(Y or N)	Cost of activated carbon, Cc:	$2.330	($/lb)
Emission stream LEL, LEL:	1,200	(ppmv) Table 4.2-1	Natural gas price:	$3.550	($/1000 scf)
No. adsorb carbon beds, NA:	1		Base or precious metal catalyst:	PM	(Enter "BM" or "PM")
No. desorb carbon beds, ND:	1		Cost of PM catalyst:	$3,000	($/ft3)
Operating hours/year, HRS:	2,560	(hours)	Cost of BM catalyst:	$775	($/ft3)
Operating labor cost:	$30.00	($/hr)	Density of flue gas, De:	0.074	(lb/scf) From Page 4-5
Maintenance labor cost:	$30.00	($/hr)	Density of fuel gas, Df:	0.041	(lb/scf) From Page 4-5
Regeneration steam req., St:	1.0	(#stm/#crbn) Table 4.6-2	Mean heat capacity of air, Cp:	0.019	(BTU/scf F) From Table C.6-1
Adsorb cycle time, Oad:	2	(hour) Table 4.6-2	Stream oxygen content:	20.6	(%)
Regen. cycle time, Oreg:	2	(hour) Table 4.6-2	Reference temperature, Tr:	77	(deg F)
Dry-cool cycle time, Odc:	15	(min) Page 4-34	Lower heat value of nat. gas:	21,503	(BTU/lb) From Page 4-14
Bed stream velocity, Ue:	100	(ft/min) Page 4-32	Heat x eff, thrml rec & Ca/ox, HR:	70	(%)
HAP heat content:	17,000	(BTU/lb)	Heat xchngr effic, thrml reg, HR:	95	(%)
Carbon Adsorb removal effic, RE:	95	(%)	Heat xchngr effic, cat incin, HR:	70	(%)
Therm incin removal effic, RE:	95	(%)	Value of recovered HAP, Vhap:	($0.032)	($/lb)
Cat incin removal effic, RE:	95	(%)	Max desired stream heat cont, hd:	13	(BTU/scf)
Most recent CE cost index:	358.6		Capital recovery factor, CRF:	0.1627	(10 years at 10.0%)
Month & year of above CE index:	April, 1992		CE cost index for base year:	340.1	April 1988
Temp. for 1 mm Hg vapor pressure:	-48.13	(Deg C) Perry Table 3-8	Cost of site prep, SP:	$0	($)
Temp. for 100 mm Hg vapor pressure:	19.93	(Deg C) Perry Table 3-8	Interest Rate:	10.0%	(Percent)
Heat of Vaporization at Tcon, dH:	10	(Btu/lb) Perry Fig 3-9	Peak Emission Flow Rate:	10	(scfm)
HAP Spec Ht at condense temp range:	0.153	(cal / g C) Perry Table 3-177	Refrigerator Efficiency, Er:	65	(Percent)

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Worksheet for Costing
Absorption
Control Technology

Building 110 Expansion - Module E

Average Flow Rate, Qe	10	(acfm)	Packing constant a	28	
Maximum Flow Rate, Qavg	10	(acfm)	Packing constant e	0.74	
Temperature, Te	77	(DegF)	Fraction of Flooding V., f	0.6	
HAP	VOC		Packing constant b	3.82	
HAP Concentration, HAPe	185034	(ppmv)	Packing constant c	0.41	
Pressure, Pe	760	(mm Hg)	Packing constant d	0.45	
Removal Efficiency, RE	58.8	(%)	Packing constant Y	0.0125	
Mol Wt of Em Str, MWe	70.87	(lb/lb-mol)	Packing constant s	0.22	
Solvent Used	Water		Packing constant g	11.13	
Slope of Equ. Curve, m	2.64	Perry Fig 14-14	Packing constant r	0.00295	
Mol Wt of Solvent, MWsol	18	(lb/lb-mol)	Bed Type	SINGLE	
Disposal Cost of Solvent, Dsc:	$286.00	($/1,000 gal)	Packing Material Cost, Pcost	12.75	($/ft^3)
Schmidt # in Gas, Scg	1.24		Hours / Year, HRS:	2580	(hr)
Schmidt # in Liquid, Scl	804	Ul/(Pl * Dl)	Elec. Cost, USelec:	0.059	($/kWh)
Solvent Density, Dl	62.18	(lb/ft^3)	Water Cost, Pcw:	0.20	($/1,000 gal)
Solvent Viscosity, Ul	0.815	(cp) Weast Pg. F-42	Operating Labor Cost:	30	($/hr)
Absorption Factor, AF	1.6	HAP Manual Example Case	Maintenance Labor Cost:	30	($/hr)

Calculate Gas Stream Flow Rate, Gmol	1.55	(lb-mol/hr) 0.155 * Qe
Liquid Flow Rate, Lmol	6.5472	(lb-mol/hr) AF * m * Gmol
Liquid Flow Rate, Lgal	0.24	(gal/min) [Lmol * MWsol * (1/Dl) * 7.48] / 60
Solvent Flow Rate L	118	(lb/hr) MWsol * Lmol
Gas Stream Flow Rate, G	109.8485	(lb/hr) MWe * Gmol
Density of Gas, Dg	0.181	(lb/ft^3) P * M / (R * T)
Abscissa, ABS	0.058	L / G * (Dg / Dl)^2
Ordinate, ORD	0.14	Read from Figure 4.7-2
Gas Flow at Flooding, Gaf	0.874	[ORD * Dg * Dl * Gc / ((a/e^3) * (Ul^0.2))]^0.5
Gas Flow, Ga	0.524	f * Gaf
Area of Column, Acol	0.06	(ft^2) G / (3,600 * Ga)
Diameter of Column, Dcol	1.00	(ft) 1.13 * (Acol^.5)
# Gas Trans Units, Nog	2	Equation 4.7-13, HAP Manual
Liquid Flow Rate, L*	2025	(lb/hr-ft^2) L / Acol
Ht of Gas Transfer Unit, Hg	3.048	(ft) [b * (3600 * Ga)^c / (L*^d)] * Scg
Ht of Liquid Trans Unit, Hl	1.63	(ft) Y * (L*/Ul*)^s * Scl^.5
Ht of Transfer Unit, Hog	4.07	(ft) Hg + (1/AF) * Hl
Column Height, HTcol	8.1	(ft) Nog * Hog
Total Column Height, HTtot	10.4	(ft) HTcol + 2 + 0.25 * Dcol
Volume of packing mat, Vpack:	6.4	(ft^3)
Pressure Drop Thru Col, Pa	2.74	(lb/ft^2-ft)
Total pressure drop, Ptot	4.28	(in H20) Pa * HTcol / 5.2
CAPITAL COSTS		
Absorber Tower Cost	$4,967	($) Figure 4.7-4, corrected to April, 1992 $
Auxiliary Equipment	$25,000	($) Parameter
Packing Material	$86	($) Vpack * PCost, corrected to April, 1992 $
Equipment Cost, EC	$30,053	
Purchased Equipment Cost, PEC	$36,064	($) 1.2 * EC
Direct Installation Cost, DIC	$30,654	($) 0.85 * PEC
Site Preparation, SP	$0	
Building, Bldg	$0	(0.0% of purchased equipment cost)
Total Direct Costs	$66,718	DIC + PEC + SP + Bldg
Indirect Costs	$12,622	($) 0.35 * PEC
Total Capital Cost, TCC	$79,340	

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Worksheet for Costing
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Building 110 Expansion - Module E

ANNUAL COSTS

Actual Em. Str. Flow Rate, Qes:	10	
Annual Electricity Use, Fp:	20	
Annual Elec Cost, AEC:	$1	Fp * USElec
Annual Solvent Requirement, ASR:	36,293	(gal)
Annual Solvent Cost, ASC:	$7	($) ASR * Pcw * 1/1000
Operating costs:		
a) Operating labor costs:	$4,800	[(0.5 hr/shift)/(8 hr/shift)](HRS)($hourly rate)
b) Supervisory costs:	$720	0.15 (Operating labor costs)
Maintenance costs:		
a) Maintenance labor costs:	$4,800	[(0.5 hr/shift)/(8 hr/shift)](HRS)($hourly rate)
b) Maintenance materials:	$4,800	1.0 (Maintenance labor costs)
Disposal of Solvent:	$9,654	($) ASR * Dsc
TOTAL DIRECT COSTS:	$24,782	
INDIRECT COSTS:		
Overhead	$9,072	0.60 * Op. Labor + Maint
Administrative	$1,587	2% of TCC
Insurance	$793	1% of TCC
Property Taxes	$793	1% of TCC
Capital Recovery	$12,912	TCC * CRF
TOTAL INDIRECT COSTS:	$25,158	
TOTAL ANNUAL COSTS:	$49,940	
COST PER TON REMOVED:	$20,126	

Eli Lilly

Building 110 Expansion - Module E
ABSORPTION
ANNUAL COSTS

COST ITEM	FACTOR	UNIT COST	COST(*)
DIRECT ANNUAL COSTS(**)			
Operating Labor			
Operator (hrs.)	0.5 hr/shift	30.00/hr.	$4,800
Supervisor	15% of operator		720
Operating Materials			
Maintenance			
Labor (hrs.)	0.5 hr/shift	30.00/hr.	4,800
Material	100% of Maint. Labor		4,800
Utilities			
Electricity		0.059/kWh	1
Water		0.200/1000 gal	7
Wastewater Disposal			9.65[illegible]
TOTAL DIRECT COSTS			$24,782
INDIRECT ANNUAL COSTS			
Overhead	60% of sum of operating, supervisor and maintenance labor, and maintenance materials.		9,072
TCI(***)	$79,340		
Administrative Charges	2% TCI		1,587
Property Taxes	1% TCI		793
Insurance	1% TCI		793
Capital Recovery Cost Factor (****)	0.1627		
Capital Recovery	CRF x TCI		12,912
TOTAL INDIRECT COSTS			$25,158
TOTAL ANNUAL COST			$49,940

NOTES:
(*) April, 1992 Dollars
(**) Assumes 2560 hr/yr.
(***) Total Capital Investment, from corresponding Capital Costs Table.
(****) Capital Recovery Cost Factor (CRF) (10 years at 10.0%)
CRF = 0.1627

Eli Lilly

Building 110 Expansion - Module E
ABSORPTION
CAPITAL COSTS

COST ITEM	COST (*)
DIRECT COSTS	
Purchased Equipment Costs	
Absorber Tower Capital Cost	$4,967
Packing Material	86
Auxiliary Equipment	25,000
Total Equipment Cost (A)	$30,053
Instrumentation (0.10A)	3,005
Sales Taxes (0.05A)	1,503
Freight (0.05A)	1,503
Purchased Equipment Costs (B)	$36,064
Direct Installation Costs	
Foundation and supports (0.12B)	4,328
Handling and erection (0.40B)	14,425
Electrical (0.01B)	361
Piping (0.30B)	10,819
Insulation (0.01B)	361
Painting (0.01B)	361
Direct Installation Cost (C)	$30,654
Site Preparation (**)(D)	0
Buildings (E)	0
TOTAL DIRECT COSTS (B) + (C) + (D) + (E)	$66,718
INDIRECT COSTS (Installation)	
Engineering (0.10B)	3,606
Construction (0.10B)	3,606
Contractor Fees (0.10B)	3,606
Start-Up (0.01B)	361
Performance Test (0.01B)	361
Contingencies (0.03B)	1,082
TOTAL INDIRECT COSTS	$12,622
TOTAL CAPITAL INVESTMENT (TCI)	$79,340

NOTES:
(*) April, 1992 Dollars
(**) As required; disregarded for calculation purposes

APPENDIX D

INDIANAPOLIS AIR POLLUTION CONTROL SECTION (IAPCS) EMISSION INVENTORY

1990 Base Year Inventory of Ozone Precursor Emissions for Marion County, Indiana

Prepared For:

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Office of Air Management
105 South Meridian Street
Indianapolis, Indiana 46206-6015

and

United States Environmental Protection Agency
Region V
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December 31, 1992